USNO Report

U.S. Naval Observatory
Washington, DC and Colorado Springs, CO

Demetrios Matsakis

And

Francine Vannicola

CGSIC Timing Subcommittee
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Overview

- USNO Master Clock
- GPS Timing Operations
  - Precise Positioning Service (PPS)
  - Standard Positioning Service (SPS)
- Network Time Servers
- Internet and Other Time Products
- Precise Time and Time Interval (PTTI)

USNO Master Clock
Time Service Department

- **Ensemble of**
  - 70 Cesium standards
  - 21 Hydrogen masers
- **Real-time realization of UTC(USNO)**
- **Clocks incorporated into International Atomic Time (TAI)**
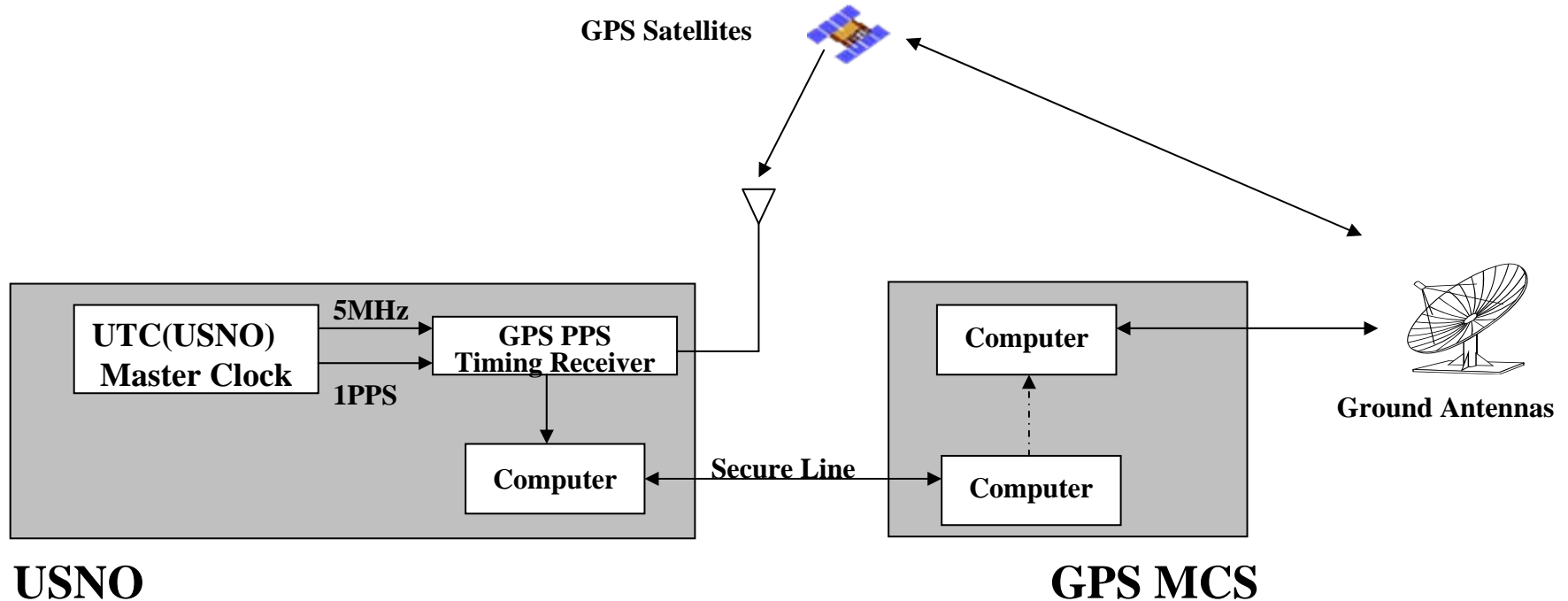
USNO GPS Operations
Time Service Department

- ## GPS Time Monitoring
  - ### Provide GPS MCS with a reliable and stable reference to UTC(USNO)
    - GPS Time Synchronization to UTC(USNO)
    - GPS Time corrections provided daily to GPS MCS

USNO GPS Operations
Time Service Department

- **GPS Time Monitoring**

GPS Satellites

UTC(USNO) Master Clock	**5MHz** → **GPS PPS Timing Receiver**
	1PPS →
	Computer

Secure Line

Computer

Computer

Ground Antennas

USNO
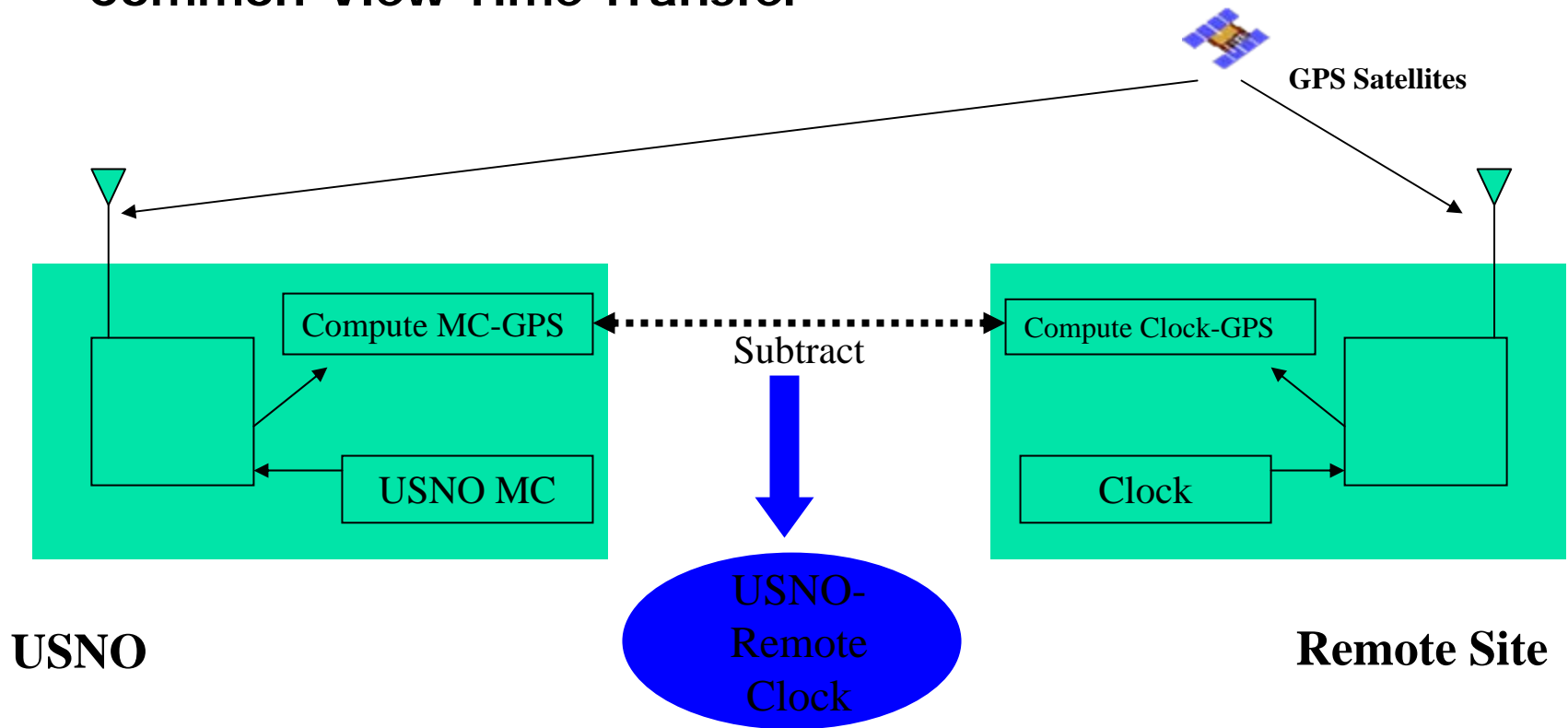
GPS MCS

USNO GPS Operations
Time Service Department

- **Common-View (CV) Time Transfer**
  - Used as a backup to Two-Way Satellite Time Transfer (TWSTT) to:
    - Incorporate USNO clocks into TAI
    - Steer Remote Clocks to UTC(USNO)
  - Participate in worldwide relative GPS calibrations conducted by the BIPM

USNO GPS Operations
Time Service Department

- **Common-View Time Transfer**

GPS Satellites

Compute MC-GPS .... Subtract .... Compute Clock-GPS

USNO MC

Clock

USNO-Remote Clock

USNO

Remote Site

Precise Positioning Service (PPS)
USNO Receivers

- ## AOA TTR-12 SM
  - 12-channel based on GPS MSRE
  - Dual-frequency
  - All-in-view Tracking
  - Temperature stabilized antenna electronics & cables

- ## Primary purposes
  - GPS Time Monitoring for GPS MCS
  - CV Time Transfer between DC & CO

- ## SAASM receivers
  - Under Development
  - Prototype unit delivered July 2004

Standard Positioning Service (SPS)
USNO Receivers
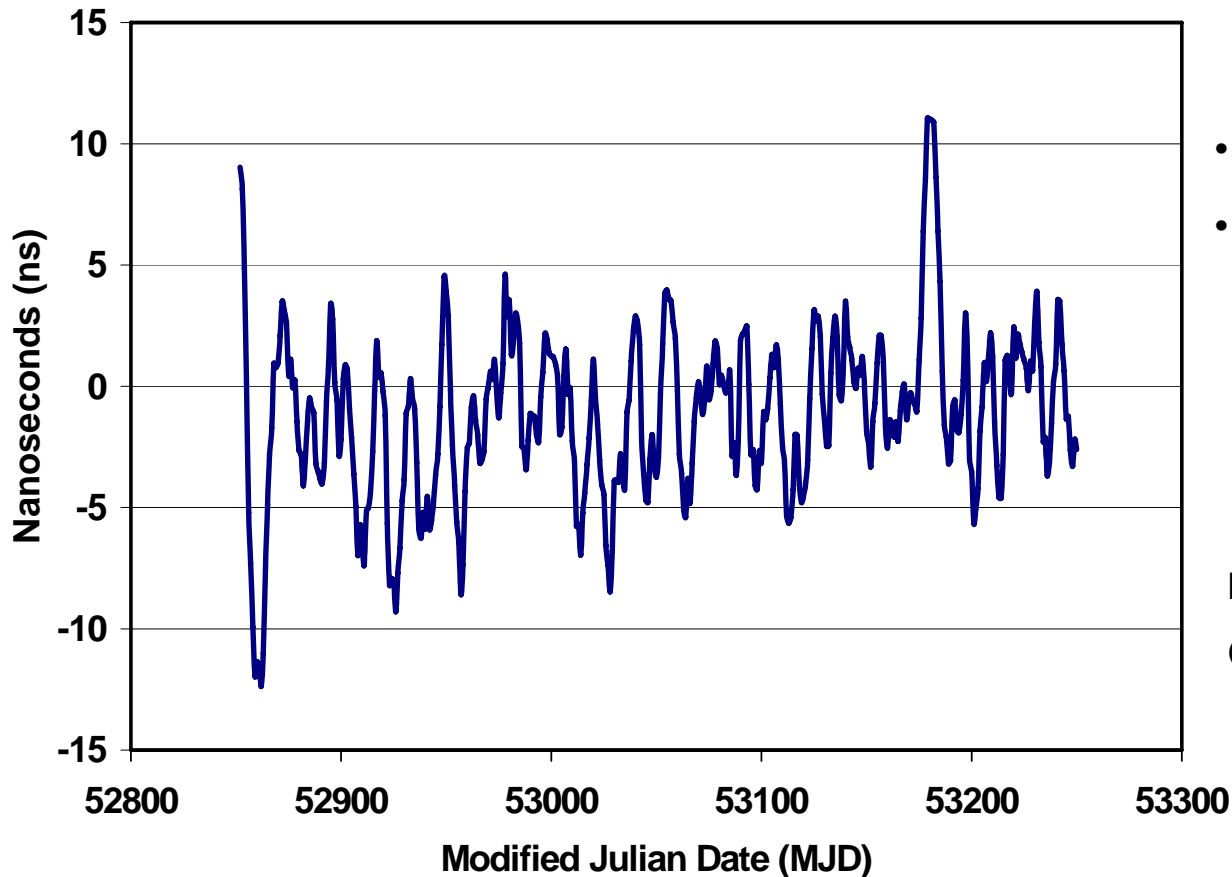
- **Current Operations**
  - Motorola Oncore-based receiver system (TTS-2)
    - 8-channel, single frequency
  - 3S Navigation GPS/GLONASS
- **Additional Systems**
  - Ashtech
    - JPL Real Time Global Differential System
  - NovAtel GPS/WAAS/EGNOS
    - Monitor UTC(USNO)-WNT

GPS Time Monitoring
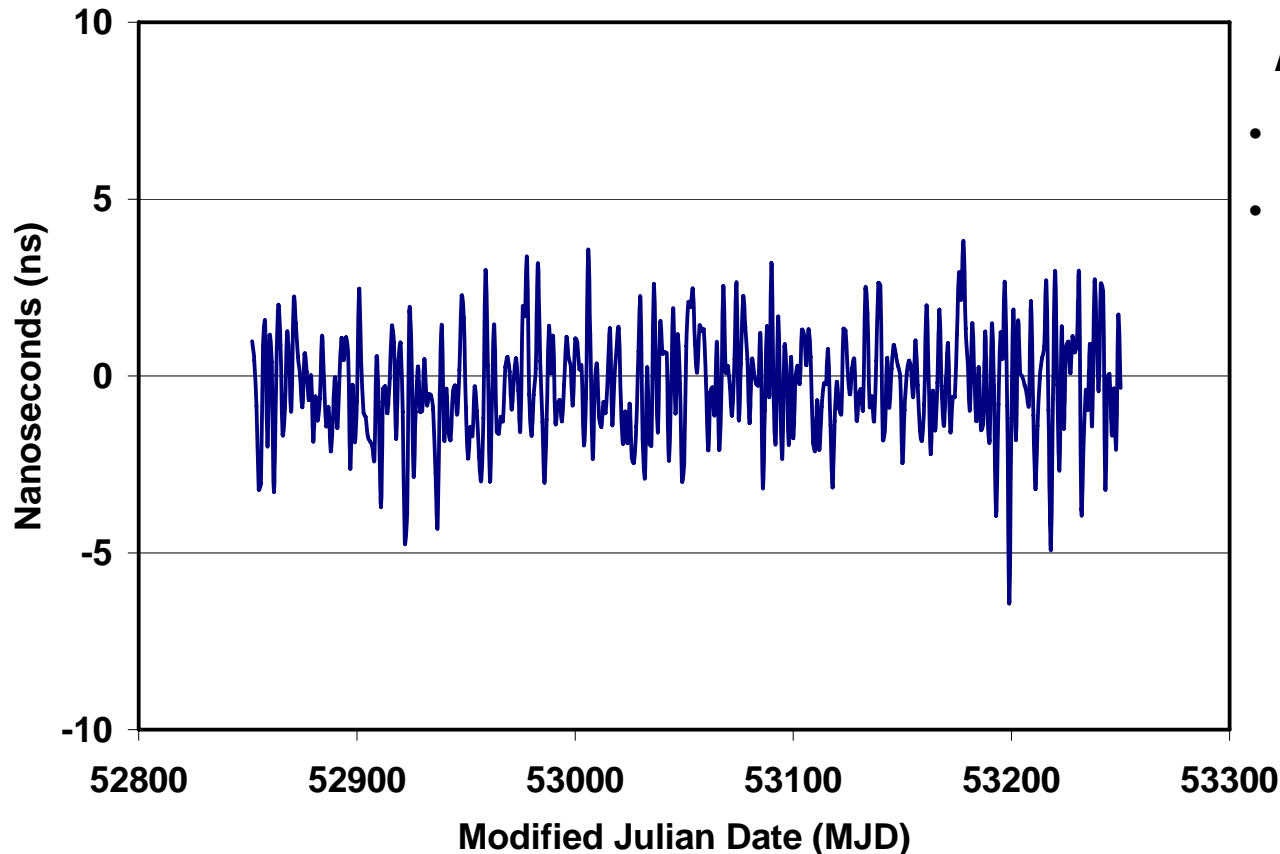## UTC(USNO) - GPS Time (via USNO PPS Receivers)

Aug 2003 – Sep 2004

- **Mean = -1.15 ns**

- **Standard Deviation = 3.5 ns**

Modulo one second

Corrected for Leap Seconds

Monitoring the UTC Available from GPS
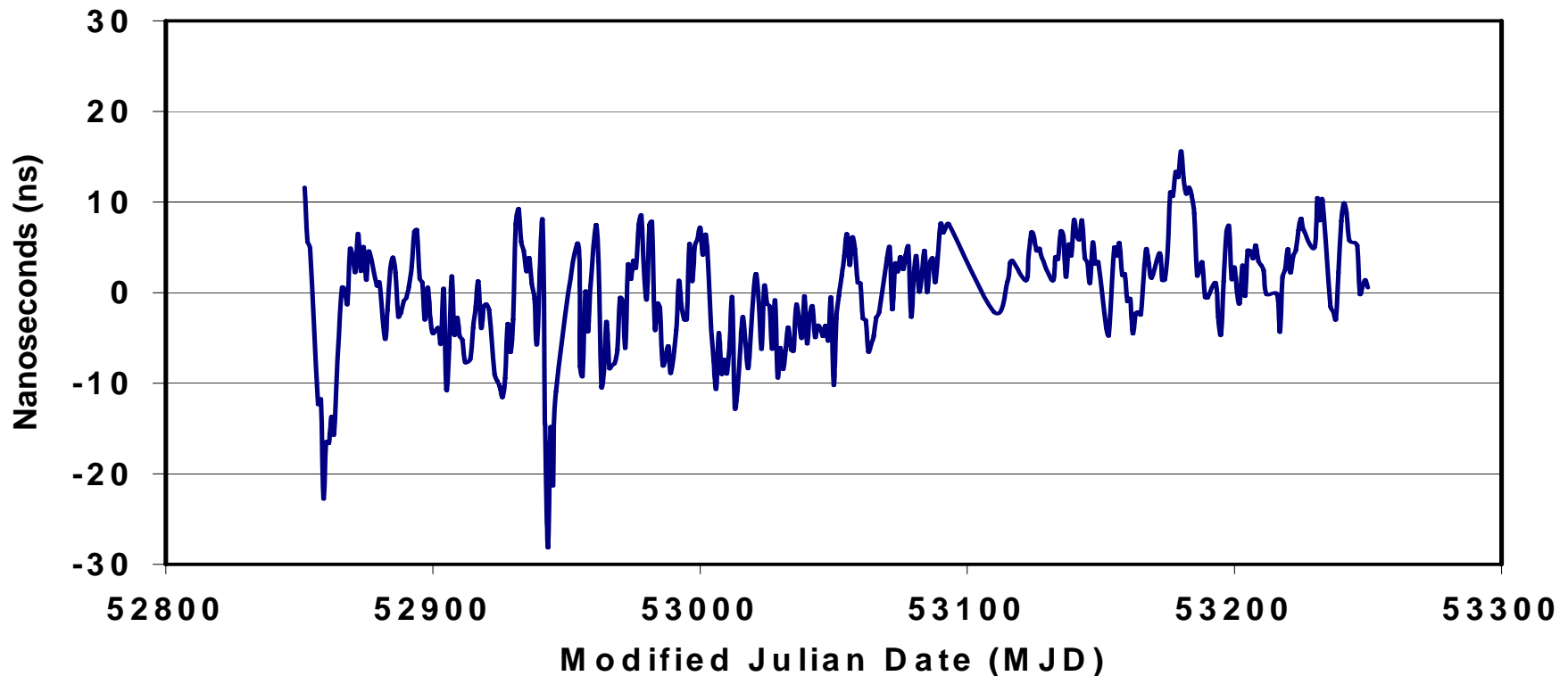## UTC(USNO)-{GPS's delivered prediction of UTC(USNO)}

Aug 2003 – Aug 2004

- **Mean = -0.25 ns**
- **Std Dev = 1.5 ns**

Y-axis: Nanoseconds (ns), range -10 to 10

X-axis: Modified Julian Date (MJD), range 52800 to 53300

WAAS Network Time (WNT) Monitoring
UTC(USNO) –WNT, offset removed

August 2003 - September 2004

USNO Network Time Servers

Time Service Department

- **Internet http://tycho.usno.navy.mil/ntp.html**
  - 26 U.S. Stratum-1 Time Servers
  - USNO Master Clock & GPS SPS Time References
  - Millisecond Time Synchronization
  - 100 Billion Network Requests yearly
- **SIPRnet**
  - 2 U.S. Stratum-1 Time Servers operational
  - 2 OCONUS under consideration
  - USNO Master Clock References

- **Contact: Richard E. Schmidt, 202-762-1578 DSN 762-1578, res@usno.navy.mil**

Internet and Other Time Products
Time Service Department

- **ftp server, ftp://tycho.usno.navy.mil**
  - 9 million connections/month
- **Time Service Web server, http://tycho.usno.navy.mil**
  - 5 million connections/month
- **Telephone Voice Announcer**
  - USNO DC, **202-762-1401 (DSN 762)**
  - USNO AMC, **719-567-6742 (DSN 560)**
- **Modem Time**
  - USNO DC, **202-762-1594 (DSN 762); 1200 baud 8N1**
  - USNO AMC, **719-567-6743 (DSN 560); 1200 baud 8N1**

Precise Time and Time Interval
PTTI Annual Meeting

- **Objectives**
  - Disseminate and coordinate PTTI information at the user level
  - Review present and future PTTI requirements
  - Inform Government and Industry engineers, technicians, and managers of precise time and frequency technology and its problems
  - Provide an opportunity for an active exchange of new technology associated with PTTI
- **Meeting Information (http://tycho.usno.navy.mil/ptti.html)**
  - Sponsors: USNO, NRL, NASA JPL, USCG NAVCEN, DISA, USAF
  - Attendees: U.S. government, military, industry and international
  - **36th PTTI: December 7-9, 2004 in Washington, DC**

DISCLAIMER

- Manufacturers and products are identified only for technical clarity

- Use by USNO does not imply an endorsement

- Past record at USNO may not be a reliable predictor of future performance.